Ostrich Study in South Africa.

By PROF. J. E. DUERDEN.

THE domestication of the two-toed ostrich in South Africa has rendered available for observation and experiment large numbers of a creature in many respects worthy the attention of zoologists. While this bird's lack of intelligence and absence of any personal recognition may discourage the lover of animals who looks for some response for care and attention bestowed, its towering size, wayward strength, and nuptial viciousness yet engender a wholesome regard. The high industrial importance which attaches to its plumage has made necessary an intensive study of the physiological conditions which influence feather growth, as well as of the genetical considerations which determine its advance. It is true that, as the foundation of an industry appealing only to adornment and luxury, the bird fell on evil days during the war; but the outlook for the future is now encouraging.

Though in the wild state the ostrich is one of the most nervous of birds, its instinctive fear of man the unusual can be kept in abeyance on the farm by close association and constant handling from the chick stage onwards, and with intelligent control it is rendered amenable to all the necessary restraints of domestication. Should neglect occur, however, the wild nature asserts itself, and restraint is afterwards impossible, irresponsive as it remains to any "breaking" process.

During the past fifty years or so the farmer has worked out the main conditions necessary for the production of plumage of the highest excellence, without, however, any concern as to the physiological principles involved. As epidermal outgrowths, growing at the rate of a quarter of an inch a day, the unripe plumes are found to be extremely responsive to any variation in the condition of nutrition of the bird. Even the slight difference of blood-pressure between day and night is often found to leave its impress on the growing feather in the form of an alternation of denser and weaker annulations, while, should the bird be in a reduced state, a kinking of the feather sheath at a ring of night growth may result in the formation on the opened plume of the familiar defects known as "bars" (Fig. 1). Reduced nutrition may even result in complete stoppage of feather growth, particularly in the case of chicks, a new plume pushing out the old on the restoration of better conditions. Of all parts of the body, epidermal structures seem the first to suffer from insufficient nutrition and to retain a more or less permanent impress of it, as is so often exemplified in nails, hoofs, horns, wool, and hair; but in the rapidly growing ostrich plume the response appears more manifest, and an economic importance attaches thereto.

The clipping of the plumes is no more harmful to the bird than is the cutting of the hair or the trimming of the nails to ourselves. They are taken as soon as opened out for fear of deterioration, while the quills are allowed another two months in which to complete their growth. Several helpful facts are disclosed on the extraction of the quills. Thus, the drawing of the quill invariably serves as a stimulus to the germ below, and the new feather appears at the lip of the socket in about a month's time. All being drawn simultaneously, a full, even crop of plumes is secured, each regular and perfect in its growth, owing to mutual protection—a great contrast with a crop from a wild or uncared-for bird, which is made up of plumes at all stages of growth as a result of moulting irregularities. Before maturity of plumage is reached, a feather drawn out of time is intermediate in character between those of the plumage before and those coming after. The time of quilling is the most critical of all the operations connected with the farming of the bird, as it determines largely the nature of the succeeding feather crop. The state of nutrition, sexual stage, period of the year, and climatic and food conditions have all to be considered. Where only a single clipping annually is secured, adult birds are, if possible, quilled at such a period as will bring the crop to ripeness about the beginning of the breeding season—that is, the middle of winter.

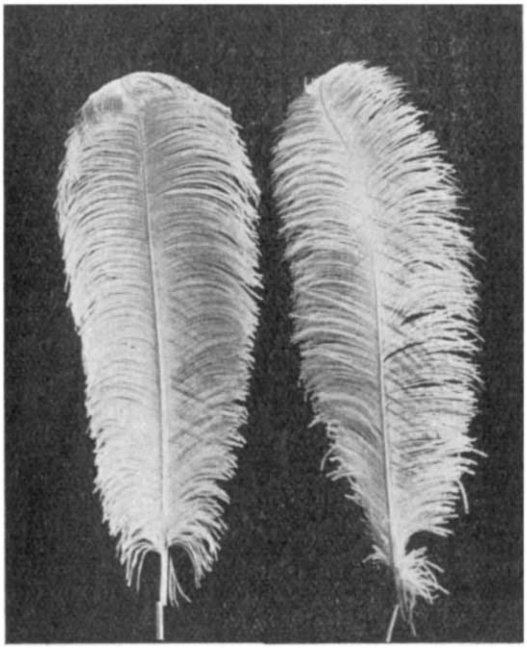

FIG. 1.—Ostrich plumes showing barring defects and sloping butts, results of reduced nutrition.

While the growing plume is highly responsive to changes of nutrition, the farmer soon discovered that the response was limited, and that with all his care only certain birds produced superior plumes. As in other domestic animals where much importance is attached to details of form and production, great variations in the minutiæ of feather structure were encountered, all of which have a big industrial bearing. Scarcely any two birds produced plumage alike in character, and the whole object of the breeder has been to bring together in a single plume the best of all the characteristics distributed among the original wild stocks. Without any knowledge of Mendelism or of the factorial hypothesis, the ostrich farmer has clearly grasped the genetic distinctness of the innumerable "points" of the plume, and the impossibility of procuring those desired except from birds already exhibiting them. The best plumage birds in South Africa to-day are the product of only two or three original strains; all the rest have been discarded as breeders, through not showing sufficient merit. No new character or mutation in plumage has ever occurred since domestication. Selection in breeding is based on plumage alone, no bodily characters having been found to be correlated with it. It is manifest that any ostrich of weak metabolic activity would necessarily produce a defective plume also and be discarded on performance alone, however desirable the plume factors of the germ might be known to be; hence the farmer is more justified in selecting his breeders on production than he would be in selecting on pedigree alone. It is not much that the geneticist can do for the practical breeder in cases of this kind; he can, however, expound to him the soundness of the principles on which he is working and thereby encourage him in his efforts.

Along with the other members of the ratite group, the ostrich has long been regarded as in many respects degenerate or as undergoing retrogressive evolution. The relative smallness of the wings and the presence of only two toes to the foot are manifest features, but a closer study reveals many other directions in which loss has taken place, particularly in connection with the epidermal derivatives, scales, feathers, and claws. The thousands of specimens available provide ample material for observing the various stages in the process and the manner in which the loss proceeds. In such studies it becomes important to distinguish between diminution in size and the loss of constituent parts of a structure. Thus, although the wings are so disproportionately small, structurally they are actually less degenerate than in any other living bird. The first and second digits bear claws, and the third digit has sometimes a free second phalanx and may bear feathers. The outer toe of the foot is far less in size than would be expected of the fourth in the sauropsidan sequence, yet it retains all its five phalanges. Also, as showing the independence of the degenerative changes one of another, it may be observed that, though the wing is structurally less reduced than in other birds, the foot is unique in having only two toes; it is more degenerate than in any other living bird.

That a type has undergone degeneration in any respect can be established only by comparison with closely related members of the group to which it belongs, comparative anatomy affording us a safe standard. On this basis there can be no question of the various lines of degeneration represented in the ostrich, and if among the multitude of specimens examined differences of degree are met with along these lines, it is a fair inference that they represent the various stages of the process, and reveal to us the manner in which evolution proceeds. Whether the occurrence of these intermediate stages within extremes proves that evolution is actually in progress to-day may be a reasonable inference in the case of such an animal as the ostrich; but, as Prof. Bateson has pointed out, it can be definitely established only by comparisons at long intervals of time showing a general average reduction.

Comparing, then, the various stages in the degeneration of any particular feature of the ostrich, it is found that wherever a sufficient number of individuals can be got together a continuous series is presented, linking up the extremes (Fig. 2). Thus birds are to be found with wing quills varying in number all the way from 44 to 33; the under-covering of down may be practically lacking, while all stages occur leading up to a feeble development over the greater part of the body; the under-surface of the wing may be naked with the exception of a much reduced single row of under coverts, but intermediate stages occur culminating in three rows of coverts; many degrees in reduction of the upper coverts are also encountered; the second phalanx of the third finger varies from a free distinct bone to a triangular vestige fused to the end of the first phalanx. On the little toe the claw varies from a stage where it is well developed to one where it is altogether absent, and the scutellation of the big toe may

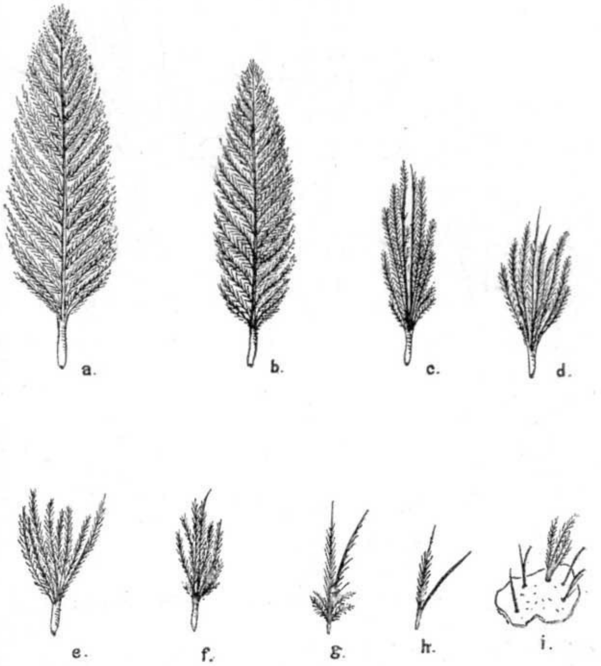

FIG. 2.—Series showing stages in degeneration of a feather.

either be continuous with that on the tarsus or show stages in "breaks" at one or two of the joints (Fig. 3). These and other facts of a like character go to prove that the degenerative evolutionary processes in the ostrich are all *orthogenetic* in their nature, and that a retrogressive change set up in any one direction is likely to be continued until final elimination of the part in question. The continuity is probably more apparen than real; for if the somatic changes correspond with alterations in the germ plasm, it must be inferred that these are discrete in their origin, and apparent continuity is conferred mainly by intermixture and owing to the smallness of the changes. The stages must, however, be successional and represent a definite tendency in the germ plasm, in contrast to the haphazard nature of the mutations usually studied—a tendency which is held to be wholly apart from any considerations as to the welfare of the bird, as well as from environmental influences.

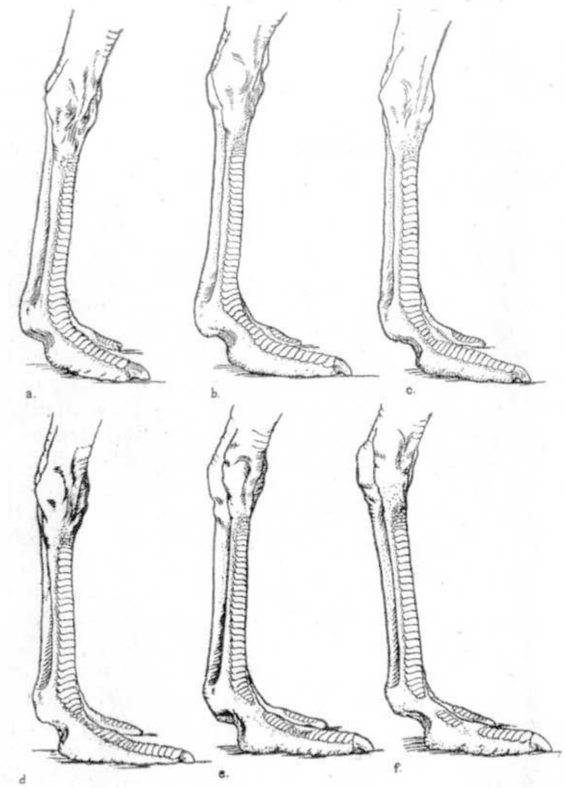

FIG. 3.—Series showing various stages in the loss of scales over the big toe.

To the highly contentious question of the inheritance of acquired characters, the ostrich would appear to have a contribution to offer. Owing to the loss of its second toe, the crouching bird, for mechanical reasons, no longer makes use of the symmetrical axial callosity at the ankle, but develops an accessory one to the side. This is formed anew with each generation, and must have done so ever since the second toe disappeared, though presumably this happened thousands and thousands of generations ago. No hint of the accessory callosity occurs on the newly hatched chick; it is not inherited, but has to be acquired anew each time. On the other hand, the hereditary axial callosity, though unused for the same period, shows no signs of reduction; it has persisted through the ages, though non-functional. Further, the ostrich rests upon its sternal and pubic projections, and a strong callosity is developed over each. These would unquestionably form as a direct response of the skin to the pressure and friction involved in crouching, but are found to be hereditary, showing on the newly hatched chick. Hence we are presented with an hereditary structure which would also be formed independently as a result of the ordinary activities of the bird were it not already provided, strongly compelling us to suspect that the presence of the former is in some manner directly connected with the latter; in other words, that a character originally developed as a result of external stimuli has in time become so impressed upon the organism that it now makes its appearance apart from the primary stimuli.

The question of the origin of the three or four species of ostrich also makes some appeal to the evolutionist. No one intimately acquainted with the northern and southern ostrich would dispute their specific distinctness, but the East African and Somali species appear to be founded on intermediates of the two. Moreover, the northern and southern birds freely interbreed, and their offspring are fertile, some of the characters blending and others showing Mendelian segregation. Unquestionably all the representatives of the genus Struthio are a common stock, continental in their distribution, in which mutations have occurred in certain areas and not in others, but not of such a nature as to prevent free interbreeding.

The Conservation of Our Coal Supplies.[1]

By PROF. J. W. GREGORY, F.R.S.

COAL is the main material foundation of British industrial supremacy. The importance of coal is given by Mr. Justice Sankey as his first reason for its State ownership. The rapid British industrial progress at the end of the eighteenth century was due to our abundant coal. Modern coal mining began in Belgium earlier than in Britain, but British mines soon had the greatest output in the world. In 1800 they produced two-thirds of the world's coal, in 1860 the proportion was 60 per cent., and in 1913 the United States,

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[1] Address to the Philosophical Society, Glasgow, on March 10.